A COMMON HUMIDITY ERROR

By W. J. HUMPHREYS

[Weather Bureau, Washington]

Many people who should know better seem to have surprisingly vague if not even confused ideas about humidity, and where there is much smoke there generally is some fire. Those who have to do with the measurement of humidity would insist, if questioned, that they know perfectly well what the terms "absolute humidity" and "relative humidity" properly mean. Perhaps they do; nevertheless many, if they should condescend to answer at all, would say, in substance, that absolute humidity is the mass of water vapor present per unit volume of the air, and relative humidity the ratio of the amount of water vapor present to the amount necessary to saturate the air at the same temperature.

That sounds familiar and orthodox, but it reveals confusion at best, for the air has nothing to do with either absolute humidity, properly defined as the mass of water vapor per unit volume (of space, not air), or relative humidity—the ratio of the mass of water vapor present per unit volume (of space) to that which would saturate a unit volume at the same temperature. Be certain not to add "and same pressure," which we sometimes hear, for that refers to the atmosphere, which, as just stated, has nothing to do with the phenomenon in question.

There is, however, one very useful humidity concept that does involve the air, namely, the mass of water vapor per unit mass of humid air. This is called "specific humidity."

But entirely apart from definitions we often see and hear expressions about the air taking up water vapor and about the great avidity of warm air for water vapor. Now, as a matter of fact, the air does not "take up" water vapor—it is not a sponge; and warm air has no avidity, chemical or other kind, for water vapor. All the air does in this connection is to slow down the rate of evaporation and diffusion. It is not the air but the space, air or no air substantially alike (a shade better without the air), that has the vapor capacity. Neither is it the temperature of the air but the temperature of the vapor (again air or no air) that determines the amount of water vapor per unit volume necessary to produce saturation.

Most of us say the air takes up water vapor. Let us forget it, if we can, and say space instead, as that is what we mean, if we understand the phenomenon aright.

TEMPERATURES IN THE HIGHER LAYERS OF THE STRATOSPHERE OVER LINDENBERG

BY J. REGER

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In making this study of temperatures in the stratosphere the author has chosen a total of 123 sounding-balloon flights, 81 of which were made in the last four years and the remainder in earlier years. No flights in which the clock stopped prematurely, or which failed to reach a height of at least 17 kilometers, were used in the study, and since temperatures in only the upper levels were to be considered, the 14-kilometer altitude was chosen as the starting point.

Two tables of observed data were compiled and summarized. Some of the more interesting points brought out are as follows:

(1) The yearly means indicate an almost constant temperature from 14 to 16 kilometers and thereafter a slow increase, the mean values at 20 kilometers being 1.43° C. higher than at 14 kilometers.

(2) In winter there appears to be a mean decrease of 2.57° C. from 14 to 20 kilometers.

(3) In summer the mean values indicate the temperature at 20 kilometers to be 4.27° C. higher than at 14 kilometers.

(4) The means of seven flights made in summer and autumn near or after sunset give temperatures at 20 kilometers 1.04° C. lower than those at 14 kilometers.

(5) The means of 10 summer flights made near midday show an increase of 5.01° C. from 14 to 20 kilometers.

Points (2) and (3) would seem to indicate a seasonal variation in temperature between 14 and 20 kilometers. However, the author brings out the fact that the starting time for the greater part of the flights was about 8 a. m., and since there is considerable seasonal difference in the altitude of the sun at this time, the increase may be due to insolation effect. He thinks this theory is supported by points (4) and (5), which indicate a diurnal variation of about 6° C. between noon and evening at 20 kilometers, while the mean temperatures at 14 kilometers differed very little. It is his opinion that there is probably no diurnal variation at 20 kilometers and that therefore most of the increase in temperature from 14 to 20 kilometers must be due to insolation effect.

Therefore, the conclusion is reached that sounding-balloon flights should be made during a lower sun if possible. If this were done, reliable observational data would eventually be collected for great heights where the ventilation, measured in terms of air density × vertical speed of ascent, is small. It is obviously important that the insolation effect be negligible where the ventilation is poor.

Remarks by abstracter.—The investigation of ventilation and insolation effects on indicated temperatures in the higher levels is very important, as all temperature records in the stratosphere are open to question when considered in this light. In the determination of ventilation effect on the temperature element the importance of testing under reduced pressure should not be overlooked, since the ventilation at small air densities must be poor even with a rate of ascent which would be favorable in the lower levels. If it is found impracticable or impossible to maintain sufficient ventilation in the upper levels by increasing the rate of ascent, it may be necessary to make all sounding-balloon flights after sunset, as suggested by Mr. Reger. Even under these circumstances it may be found necessary to compute by an empirical formula the true temperature from the indicated temperature, rate of ascent, and air density.—*J. C. Ballard.*

RUBENSTEIN'S CLIMATIC ATLAS OF THE U. S. S. R.

Reviewed by C. F. BROOKS

The temperature section, Part I, Section I, of Eugenie Rubinstein's atlas of the climate of U. S. S. R.,[1] includes detailed monthly and annual maps of sea-level temperatures; mean annual range; the progress of the mean isotherms of −5°, 0°, 5°, 10°, and 15° C. in spring and fall by 10-day intervals; the number of days in the year with daily mean temperature over −5°, 0°, 5°, 10°, 15°; differences of the successive monthly means of temperature; and two plates including graphs of the monthly course of temperature at 28 stations.

[1] Eugenie Rubinstein, Klima der Union der Sozialistischen Sowjet-Republiken. Teil I. Die Lufttemperatur. Lieferung I. Monatsmittel der Lufttemperatur im Europäischen Teil der U. S. S. R., Geophysikalisches Zentral-Observatorium, Leningrad, 1927, 45 maps and diagrams, 40 by 52 cm.

The sea-level temperature maps show strikingly the gradients in temperature along the coasts, which in winter are particularly steep along the Murman coast and the northeastern shore of the Black Sea. In spring the contrasts in the south are much diminished, but in the northeast they are very great indeed, amounting in April to 12° C. in 7½° of latitude, or 1.6° C. (2.9° F.) per latitude degree. The summer months show striking contrast (about 6° C. difference in July) between the chilly Arctic coast and the northern tundra. The larger lakes show a 2° or 3° C. excess of temperature relative to land in autumn and an equal deficiency in early summer. The annual range is under 20° on the western Arctic coasts, but 27° to 30° only 50 miles from the northern shore. In eastern and southeastern Russia the range is 34° to 39° C.

The advance of spring and fall as shown by the five isothermal maps for different temperatures indicate strikingly how spring bursts upon the plains of central Russia and how suddenly winter sets in. In central Russia the −5°, 0°, 5°, and 10° isotherms advance 400 to 700 miles in 10 days in spring, but not quite so fast in fall. In the north, however, the advance is slowed to 100 miles in 10 days. Correspondingly, the changes in temperature from month to month reach large values in spring and fall, mostly 7° to 11° for April to May and 6° to 9° for September to October.

The maps of frequencies of days above certain temperatures indicate great differences, especially in the number of days over 15° C., which might be called mild days. These range from 150 in the Crimea to 100 about latitude 52°, 50 at latitude 61°, and 0 at latitude 65°.

The maps are clearly presented, being black lines on a light brown hachured base, with blue for water (two shades, for shallow and deep). The scale is ample and the isothermal interval, 1° C., small enough for all required detail.

THE DRY SEASON OF THE PANAMA CANAL

By R. Z. KIRKPATRICK, *Chief of Surveys*

[Balboa Heights, C. Z., May 25, 1931]

1. The drawing on the opposite page is historical of the beginning and ending of the Canal Zone's dry seasons since American occupation.

2. It will be noted that there are considerable variations; but an approximate average is: Beginning January 1, ending May 5; length, 4 months 5 days.

3. The inset curve indicates the number of lockages Gatun Lake's available storage would have provided, after allotting 1,700 c. f. s. for making hydroelectric power, during each year since the canal began operation in 1914. It is evident that the Madden Dam and Reservoir (happily under construction) will be needed to tide over very dry seasons, and that the contemplated new locks and storage reservoir will take care of traffic needs until many decades from now.

THE CLEVELAND, OHIO, STORM, JUNE 26, 1931

By G. HAROLD NOYES

A violent storm, with resulting heavy damage, occurred during midday in Cleveland on June 26, 1931.

Distant mutterings of thunder had been heard during the preceding night beyond the Lake Erie horizon, with lightning showing behind the peaks of distant cumuli. The 8 a. m. observation of the 26th did not show any notably unusual conditions, other than its being oppressively warm, with temperature of 80° and relative humidity of 74 per cent. With the rising of the sun, temperatures moved upward to correspond, and the wind shifted from west to southward at 7:55 a. m. Later developments, however, led to the conclusion that even before 8 o'clock a great convectional disturbance was accumulating over Lake Erie to the west-northwestward of Cleveland. Cloud cover increased very rapidly, commencing at 8 o'clock; the sun was obscured at 8:04 a. m., and a gentle shower began at 8:29 a. m., the wind at that time shifting from southwest through west for 3 minutes, into northwest for 12 minutes, thence into north for 20 minutes, northeast for 30 minutes, then east for 22 minutes, then back to north for 6 minutes; the winds were a little gusty, but not rising above 18 miles per hour. Meantime the gentle shower continued, and temperature dropped from 80° to 71°. The barogram showed a slight notch, down and up, immediately after 8 o'clock. Distant thunder was heard at intervals from 7 a. m. on. Between 9 and 10 a. m. the activity of the lower clouds was confused, but highly significant of later developments. Detailed movements in four levels were observed, reading down: From west-northwest and west, north, and at lowest level varying rapidly from northeast, east, and east-southeast. At 10:36 a. m. gentle rain suddenly became excessive, amounting to 0.28 inch in about 5½ minutes, with wind remaining under 12 miles per hour. This rainfall catch was excellent. At 11 a. m. rain again reached a rapid but not excessive rate, with wind not rising above 15 miles per hour, mostly from the southeast. From 10 a. m. to 1 p. m. the barometer showed marked activity; from 10:10 to 10:20 there was a quick fall and rise; from 11 to 11:30 it fell 0.06 inch, then commenced rising, and rose about 0.15 inch by 1 o'clock. During this period the brunt of the storm swept over the city from the lake. At 11:49 a. m. the storm broke, the wind rose from 8 to 12 miles per hour in less than a minute to 56, with an extreme of 64 at 11:52, and rain commencing at excessive rate and continuing to 12:10 p. m., and the wind continuing above 45 to 12:15, the rain catch, therefore, at this period was considerably deficient, but was recorded as 0.41 in 15 minutes. The wind, rain, and ligthning during this period, immediately before and after noon, did severe damage. Lightning struck in many places; two men were killed outright and buildings damaged, and several electric circuits were burned out. The wind blasted shrubbery and foliage, uprooted trees, and broke off limbs, so that damage of this sort was widespread throughout the city, and thence to the eastward into the next county. The rainfall was at such rate that watercourses, both natural and those recently constructed, were inadequate to carry the runoff. In nearly all down-town localities there was little or no flooding, but in eastern parts of the city and suburbs underpasses were flooded, stopping traffic, cellars filled, culverts were washed out, and road surfaces and curbs undermined. Some insecure buildings were razed by the wind, and many plate-glass windows on the south side of Public Square were blown in. Windows in many scattered sections were broken, and this was followed by rain damage. Hail fell from 10:36 to 10:39 a. m., the pellets being up to three-eighths inch in diameter; the hail was unimportant and any damage therefrom was obliterated by the more serious damage a short time later. The pellets were flattened, showing concentric layers, finely traced. Precipitation from hail was probably not over a trace. The margins of the storm reached into central portions of the State, with greatly weakened energy, and as its maximum focus advanced eastward, or east-southeastward, into Pennsylvania it rapidly diminished in force. It was felt only slightly at Erie, Pa., and